

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

APPLICANT:	Jawad Haidar) Group Art Unit: 1793
)
SERIAL NO:	10/560,804) Examiner: Zhu, Weiping
)
FILED:	December 15, 2005) Docket: CU-4560
TITLE:	A METHOD AND APPARATUS FOR THE PRODUCTION OF METAL COMPOUNDS	

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REPLY BRIEF PURSUANT TO 37 C.F.R. § 41.41

Sir:

The following Remarks are respectfully submitted in response to the Examiner's Answer dated October 21, 2010, pursuant to 37 C.F.R. § 41.41.

REMARKS

In the Response to Argument section of the Examiner's Answer, the Examiner contends that Nie *et al.* discloses a stepwise method to produce titanium-aluminium compounds. The Examiner then refers to a number of disparate sections of Nie *et al.* and concludes that all of the features of Claims 1 and 31 of the present application are either explicitly or inherently disclosed by Nie *et al.* In reaching this conclusion, the Examiner concedes that Nie *et al.* does not specify the titanium subchlorides as claimed (in Claims 1 and 31), but contends that "the first reaction products that will need to be treated or further processed as disclosed by Nie *et al.* ('208 A1) read on the claimed titanium subchlorides because of the similarities of the reactants and the process conditions between the instant invention and Nie *et al.*

(‘208 A1)’. Applicant respectfully disagrees.

Firstly, Applicant notes that “the first reaction products” referred to in Nie *et al.* are defined in paragraphs [0028] and [0029] as “a by-product [of the first reaction] comprising a halogen moiety and the element or elements of the reducing gas”. An exemplary “first reaction product”, when TiCl_4 is reduced with H_2 , is HCl . Thus, the “first reaction products” cannot read on the titanium subchlorides recited in Claims 1 and 31, because titanium is not a reducing gas. Therefore, Applicant respectfully asserts that Nie *et al.* cannot properly be cited as teaching or suggesting this feature of the claims.

Secondly, Applicant respectfully asserts that the reactants and process conditions of the invention defined by Claims 1 and 31 of the present application are not similar to those disclosed in Nie *et al.* As such, Applicant respectfully asserts that the Examiner’s contention that the “first reaction products that will need to be treated or further processed” read on the intermediates recited in Claims 1 and 31 is incorrect and based upon a mischaracterization of the teachings in Nie *et al.* While the materials used in the methods disclosed in Nie *et al.* may, in some embodiments, include TiCl_4 and aluminium, and they may be heated to a temperature within the ranges referred to in the claims of the present application, hydrogen (or another reducing gas) is always present in the methods disclosed in Nie *et al.* Indeed, it is fundamental to the methods disclosed in Nie *et al.* that “a precursor material or a set of more than one precursor materials is exposed to reducing gas to yield a metal, non-metal or alloy and one or more first reaction products” (see paragraph [0025] for example).

Applicant respectfully submits that the specific intermediates recited in Claims 1 and 31 of the present application are not necessarily formed simply because TiCl_4 and aluminium are present in the reaction mixture in some embodiments of Nie *et al.* Nie *et al.* is silent with respect to reactions between TiCl_4 and aluminium. Indeed, Applicant asserts that Nie *et al.* teaches that, under the conditions described therein, reactions between TiCl_4 and H_2 (or other reducing gasses) are far more thermodynamically favourable than reactions between TiCl_4 and aluminium (see paragraph [0062]).

In this respect, paragraphs [0060] to [0062] of Nie *et al.* clearly teach that reactions in which a “reducing gas” (e.g. hydrogen) is used in combination with a

“reductant material” (e.g. Al) are different from those which occur if the reductant materials (e.g. Al) only are used. Nie *et al.* states that hydrogen changes the TiCl_4 reduction from a heterogeneous surface reaction on the reductant metal surface to a homogeneous gas reaction and, in paragraph [0062], that this will result in a substantial increase in the reaction rate, particularly in the case of reductant metals that have relatively small thermodynamic driving forces, such as Al. Thus, Applicant respectfully asserts that paragraphs [0060] to [0065] of Nie *et al.* teach that Al will not react with TiCl_4 in the presence of hydrogen because of its much smaller thermodynamic tendency.

Next, Applicant respectfully asserts that Nie *et al.* does not teach or suggest a method in which the TiCl_4 is reduced via a two step reduction reaction. Nie *et al.* describes a “first reaction” (see, for example, paragraph [0028]), in which the direct reduction of the precursor material (e.g. TiCl_4) by a reducing gas (e.g. H_2) yields a metal, non-metal or alloy (e.g. Ti) and a “first reaction product” (e.g. HCl). Applicant asserts that Nie *et al.* does not teach or suggest a method in which TiCl_4 is reduced via a two step reduction reaction, and therefore cannot possibly disclose the formation of the intermediates recited in Claims 1 and 31. Applicant notes that Al is only used in embodiments of the methods of Nie *et al.* in a “second reaction” (see, for example, paragraph [0029]), where it reacts with the “first reaction product”, thereby removing the first reaction product from the system and driving the first reaction in a forward direction to produce more Ti (or other metal, non-metal or alloy). Applicant asserts that Nie *et al.* clearly teaches that Ti and TiCl_4 are not involved in the second reaction. In some embodiments of Nie *et al.*, Al can also be used as a “seed” on which the Ti metal formed by reduction of the TiCl_4 by H_2 deposits in order to produce an alloy.

In complete contrast to the methods disclosed in Nie *et al.*, in the method(s) of the presently claimed invention, reduction of the TiCl_4 and subsequently of the titanium subchlorides is carried out in a stepwise manner under controlled conditions using aluminium. Hydrogen is not present in the method of the present invention. Indeed, Applicant submits that the reactions which occur during the second step of the method of the present invention would not result in the production of titanium-aluminium compounds and/or alloys in the presence of hydrogen. Applicant indicates that if hydrogen was present in the method(s) of the presently claimed

invention, titanium hydrides and titanium-aluminium hydrides, which are entirely different products from titanium-aluminium compounds and/or alloys, would be formed. Therefore, Applicant respectfully asserts that Nie *et al.* cannot properly be cited as teaching or suggesting a stepwise method including each of the first and second steps recited in Claims 1 and 31.

Applicant therefore respectfully asserts that it is improper, and a mischaracterization of Nie *et al.*, for the Examiner to argue that the reactants and process conditions between the instantly claimed invention and Nie *et al.* are “similar”. Applicant further submits that because H₂ (or another reducing gas) is present in the method of Nie *et al.*, TiCl₄ is directly reduced to Ti metal by the H₂, and the intermediates recited in the claims of the present application are not formed.

For these reasons, as well as for the other reasons set out in the Appeal Brief, Applicant respectfully asserts that Nie *et al.* cannot properly be cited as teaching or suggesting each and every feature or step of independent Claims 1 and 31 and therefore, a *prima facie* case of obviousness cannot be established in view of this reference.

Hereafter, Applicant will directly reply to each of the Examiner’s responses to the Appellant’s arguments filed in the Appeal Brief.

Firstly, the Examiner contends that Nie *et al.* discloses a two-step reduction process on the basis of the subject matter described in paragraph [0044].

Applicant respectfully asserts that the only instance where Nie *et al.* discloses the direct reduction of TiCl₄ to Ti is by using a reducing gas. Applicant submits that paragraph [0044] clearly does not refer to the majority of the reactants used in the process, but to only a small proportion of the reactants which, due to limitations of operation conditions, did not react. Furthermore, for the reasons discussed above, Applicant asserts that none of the materials referred to in this paragraph are the titanium subchloride intermediate compounds recited in Claims 1 and 31.

Applicant considers that paragraph [0044] simply indicates that some unreacted compounds may remain at the end of a batch, and that these unreacted compounds can be processed to form the desired metal, non-metal or alloy using the reactions described elsewhere in Nie *et al.* Applicant respectfully asserts that it is not appropriate to extrapolate from this paragraph that Nie *et al.* suggests performing

the stepwise reduction method(s) defined by Claims 1 and 31 of the present application.

Secondly, the Examiner has noted that Nie *et al.* discloses that TiCl_4 may be reduced to Ti through a reducing agent such as hydrogen and aluminium. However, the method of the present invention relates to a method for producing titanium-aluminium compounds and/or alloys, and not elemental titanium. Applicant asserts that it is a long-standing problem in the art (see, for example, the specification for the present application on pages 3 and 4, and the prior art referred to therein) that directly reducing TiCl_4 with aluminium results in an uncontrollable composition of compounds, which are not commercially useful. Further, Applicant indicates that such is acknowledged in Nie *et al.* (see, for example, paragraph [0044] in combination with paragraph [0011], as well as paragraph [0063] in combination with paragraph [0066]). The invention that is the subject of the present application has solved this long-standing problem in the art by providing a controlled method in which TiCl_4 is reduced using aluminium to form useful products via a stepwise reduction process with specific intermediates.

The Examiner also contends that paragraph [0066] of Nie *et al.*, which describes one of the problems associated with reducing TiCl_4 solely by a metal, would not constitute a teaching away from using Al as a reductant. In the Examiner's opinion, the statement that reducing TiCl_4 solely by metal would simply require separating the produced Ti product from the original reductant metal and reductant halide is just a statement of truth and does not constitute a teaching away.

Applicant respectfully disagrees. Applicant submits that one of ordinary skill in the art would clearly appreciate the difficulties associated with separating metallic products that are "physically trapped by one another", and would in no way be motivated from the methods disclosed in Nie *et al.* to attempt to reduce TiCl_4 using Al in the hope of producing commercially useful titanium-aluminium compounds and/or alloys. In appreciating the teachings of Nie *et al.*, one of ordinary skill in the art would have no expectation of success in reducing TiCl_4 using Al to produce commercially useful titanium-aluminium compounds and/or alloys.

Therefore, even if it is considered that the cited portion of Nie *et al.* does not strongly teach away from the presently claimed invention, a contention that the Applicant respectfully disagrees with, it should certainly be concluded that this

portion provides no teaching, suggestion or motivation for one of ordinary skill in the art to modify Nie *et al.* in an attempt to arrive at the methods as presently claimed. As mentioned earlier, it should also be concluded that one of ordinary skill in the art would have no expectation of success in reducing TiCl_4 using Al to produce commercially useful titanium-aluminium compounds and/or alloys.

Thirdly, the Examiner contends that the "first reaction products" referred to in paragraph [0044] of Nie *et al.* read on the claimed titanium subchlorides because of the similarities of the reactions of the process conditions between the instant invention and Nie *et al.*

Applicant has already responded to this contention above and reiterates those same comments.

Based upon the arguments submitted supra and in the Appeal Brief filed July 30, 2010, Applicant respectfully solicits the Honorable Board to reverse the rejections of Claims 1-7, 11-26, 31, 32, 36-40, 45, 52-55 and 62 under 35 U.S.C. §103(a) over Nie *et al.* and Claims 8-10 under 35 U.S.C. §103(a) over Nie *et al.* in view of O'Donnell *et al.*

December 16, 2010

Date

Respectfully submitted,



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